Of Geodata Challenges in OpenDRIVE Standardization

115th OGC Member Meeting – Smart Roads Summit
June 16th 2020

Michael Scholz

German Aerospace Center

Research institutes

- Aeronautics
- Space
- Energy
- *Transportation*
- Security
- Digitalisation

Space administration

Project management agency

Institute of Transportation Systems

Key facts

- In Berlin and Braunschweig
- Around 200 Employees

Research fields

- *Automotive*
- Railway systems
- Traffic management
- Multi-modal and public transport

Area of work

- Fundamental research
- Conception and strategy development
- Prototyping

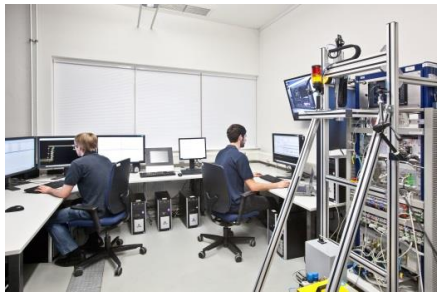
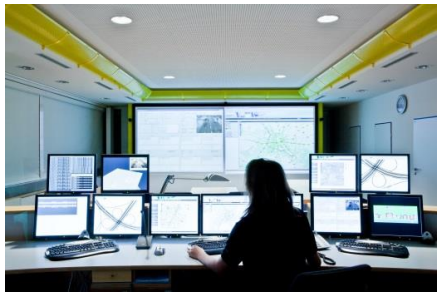
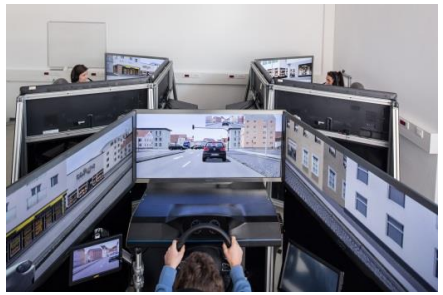
Our research infrastructure










Driving simulation

OpenDRIVE and how it works

Fancy driving simulations ...

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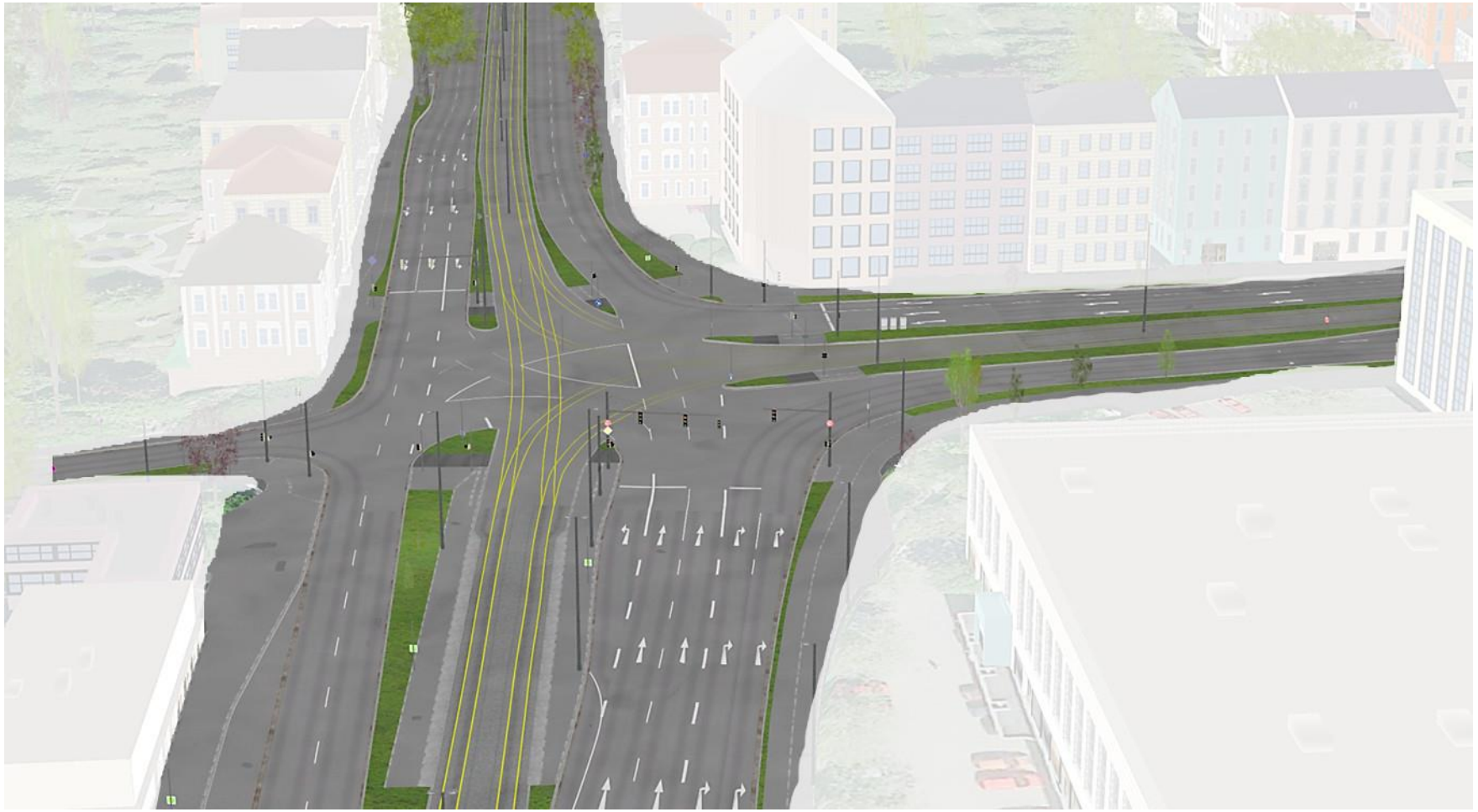
... require highly-detailed road network data



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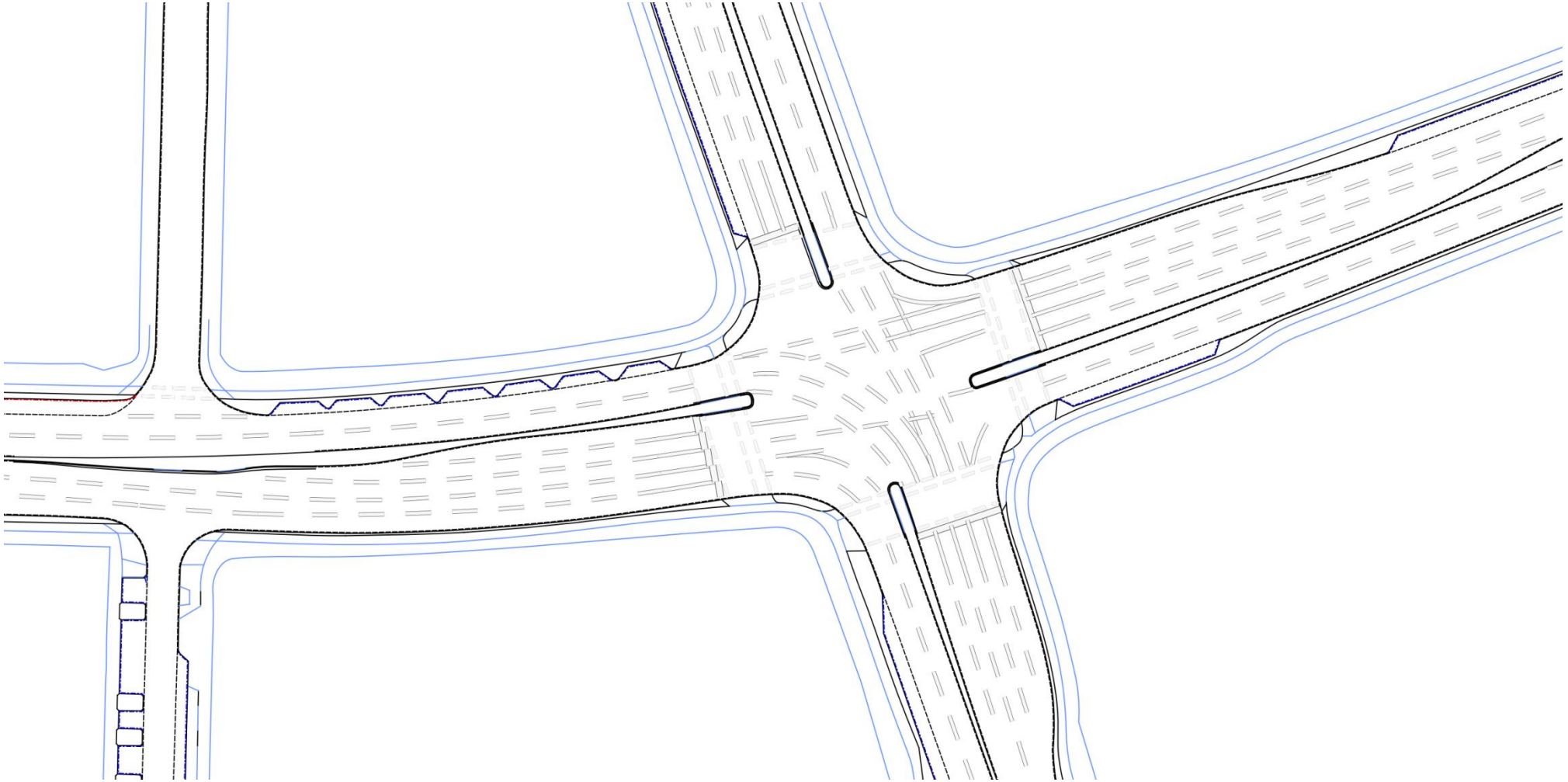
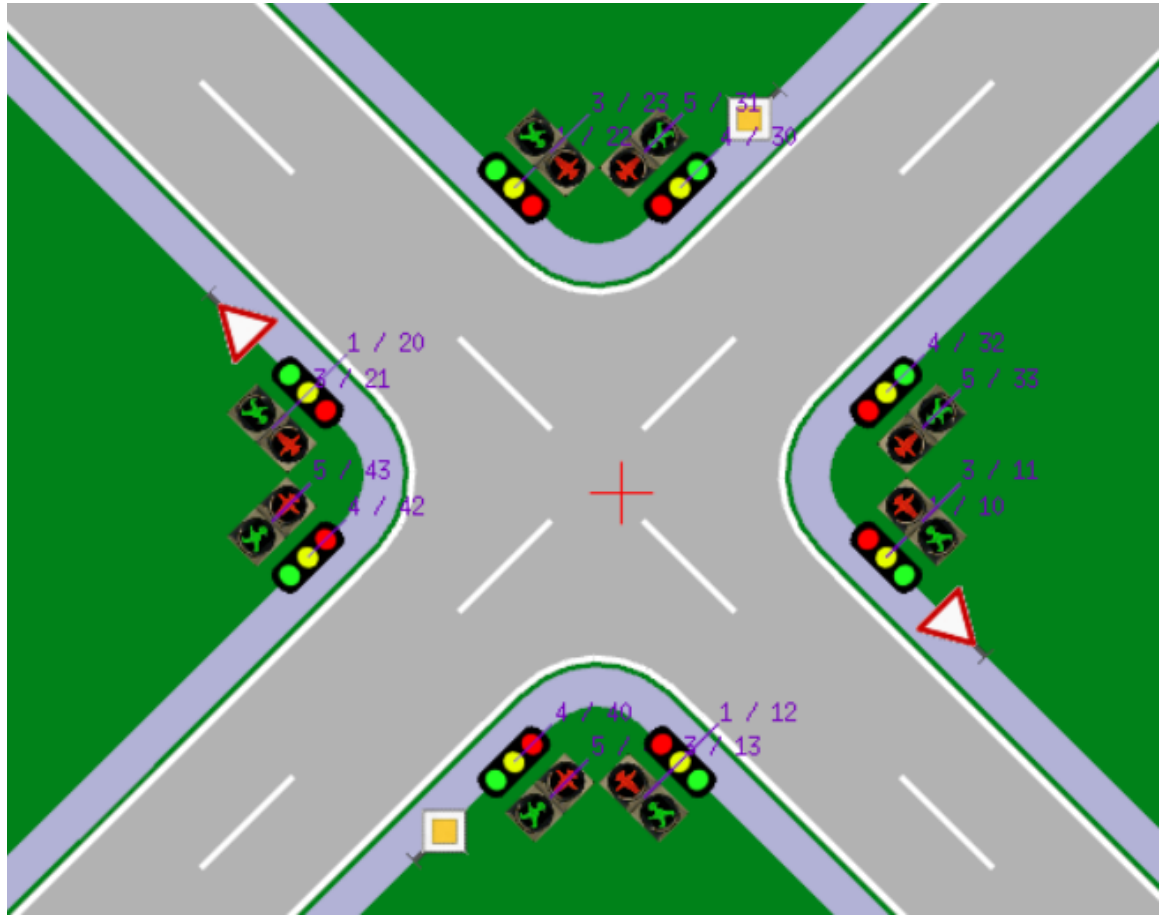


OpenDRIVE?

OpenDRIVE: initial scope of application

- Fast prototyping of simulation tracks
  → Artificial/imaginary test data
- Restricted (small) spatial extent
- High modelling detail with visual properties
  → 3D rendering
- Simple, continuous geometry definition
  → Smooth road course
- Real-time processing capability



see OpenDRIVE Format Specification, Rev. 1.5

OpenDRIVE: open industry standard

- XML-based database
- Hierarchical structure

```
<road length="1000.0" id="0">
  <link>
    <successor elementType="road"
      elementId="1" contactPoint="start"/>
  </link>
  <type s="0.0" type="motorway"/>
  <planView>
    <geometry x="0.0" y="0.0" hdg="0.0"
      length="1000.0">
      <arc curvature="0.004"/>
  <elevationProfile>
  <lateralProfile/>
  <lanes>
    <laneSection>
      <left>
        <lane id="7" type="border">
        <lane id="6" type="shoulder">
        <lane id="5" type="stop">
        <lane id="4" type="driving">
          <link>
            <successor id="4"/>
          </link>
          <width a="3.75"/>
          <roadMark type="solid" weight="bold"
            color="white" width="0.3">
            <type>
              <line length="1.0" space="0.0"
                width="0.3"/>
            </type>
          </roadMark>
```

OpenDRIVE: open industry standard

- XML-based database
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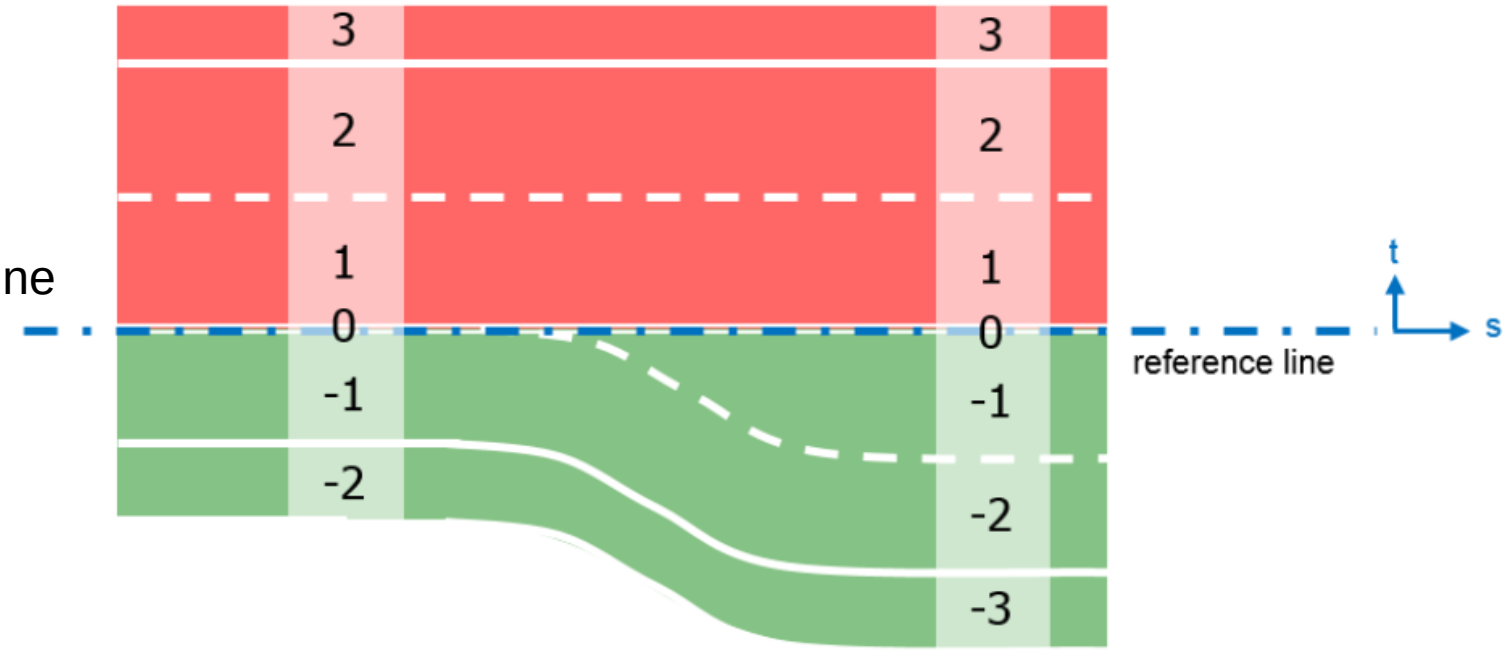
- Detailed lane modelling
- Elements refer to an imaginary reference line



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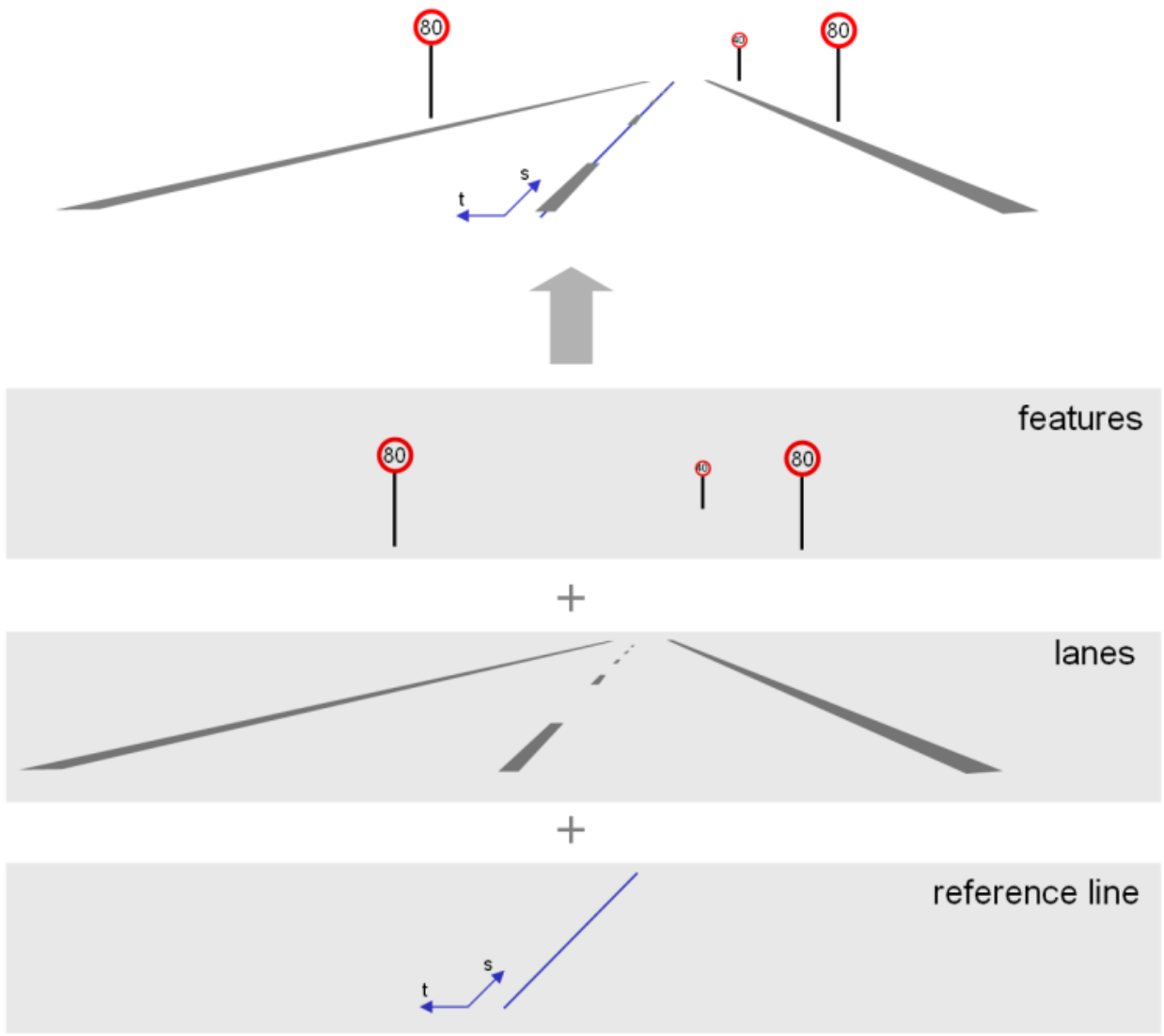

see OpenDRIVE Format Specification, Rev. 1.5

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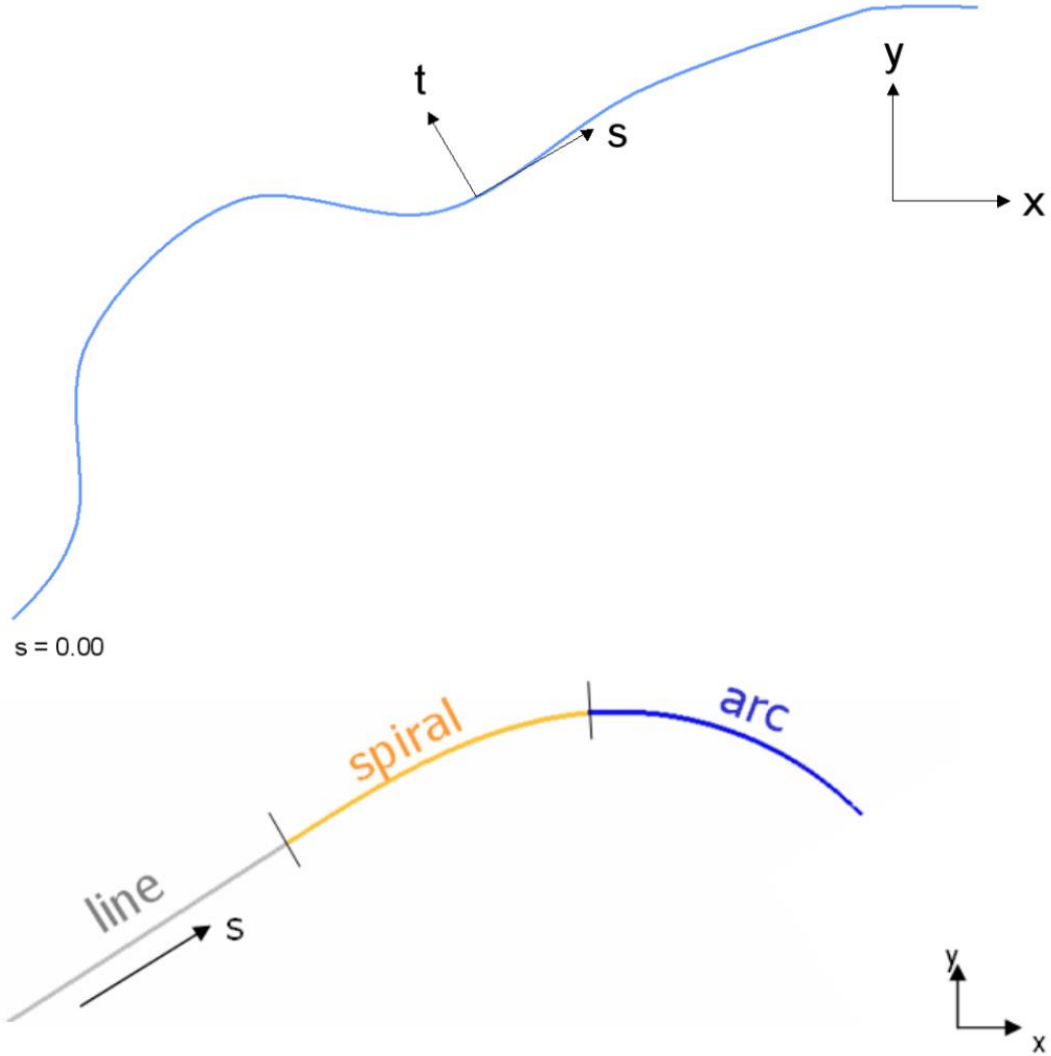
- Road topography (2.5D) and topology
    - continuous geometry definition



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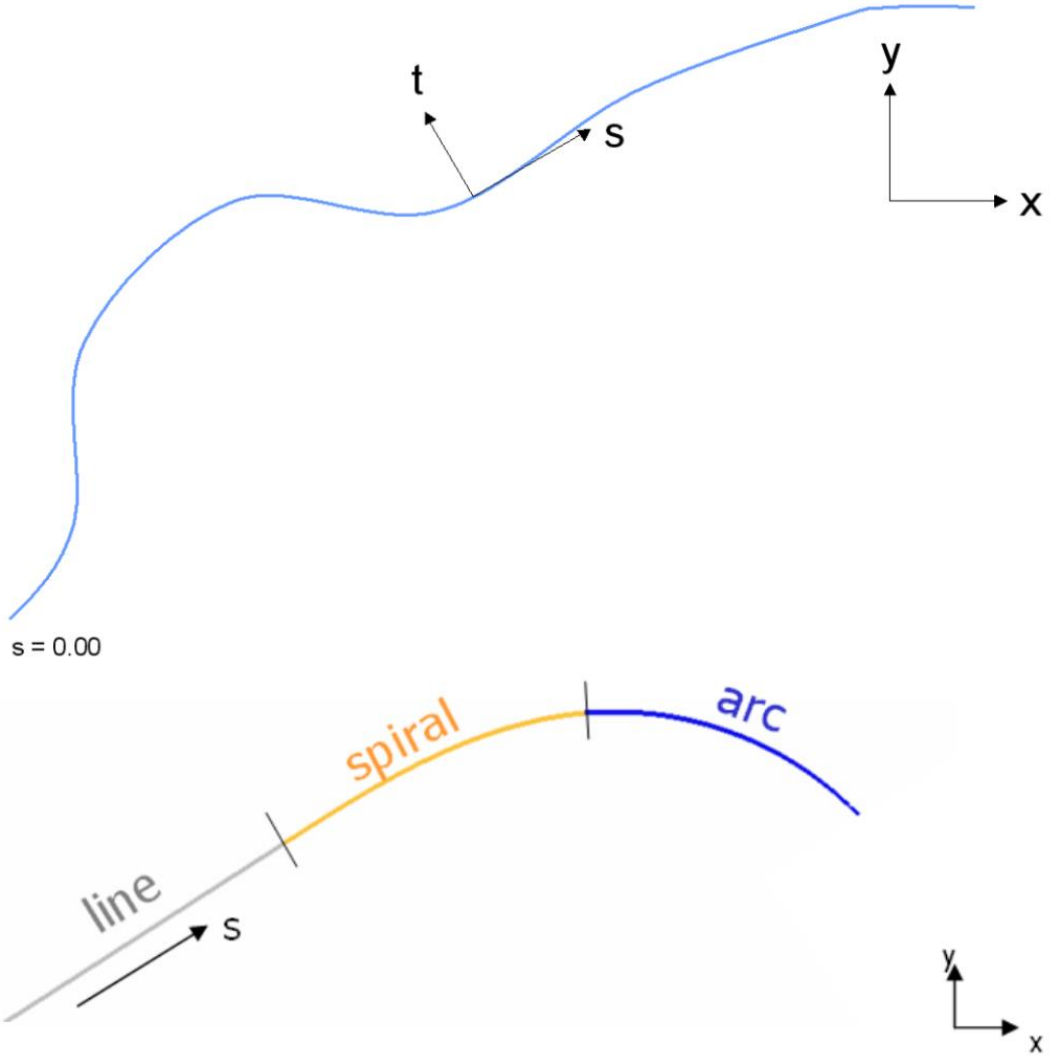
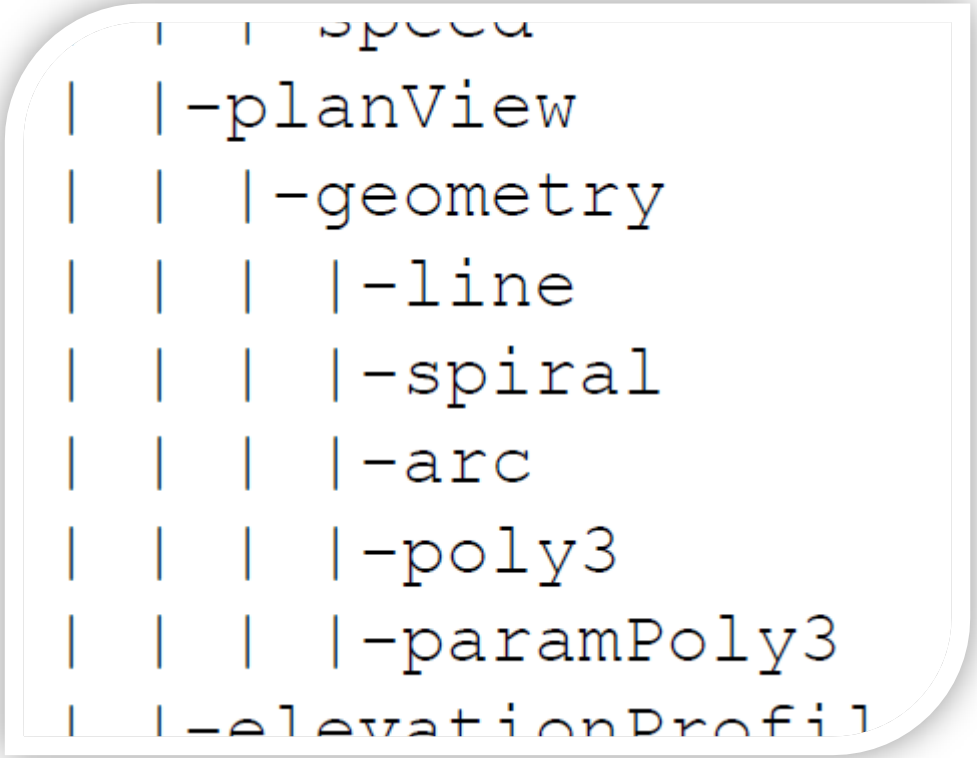


see OpenDRIVE Format Specification, Rev. 1.5

OpenDRIVE: reference line geometry representation



OpenDRIVE Format Specification, Rev. 1.5

OpenDRIVE: discrete geometry anchor points

```
<planView>
  <geometry s="0.0" x="604944.1037"
            y="5792860.1272"
            hdg="3.5148"
            length="9.7589">
    <arc curvature="9.0884E-4"/>
  </geometry>
  <geometry s="9.7589" x="604935.03"
            y="5792856.5285"
            hdg="3.5237"
            length="12.0">
    <line/>
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OpenDRIVE: continuous geometry evolution

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OpenDRIVE over time

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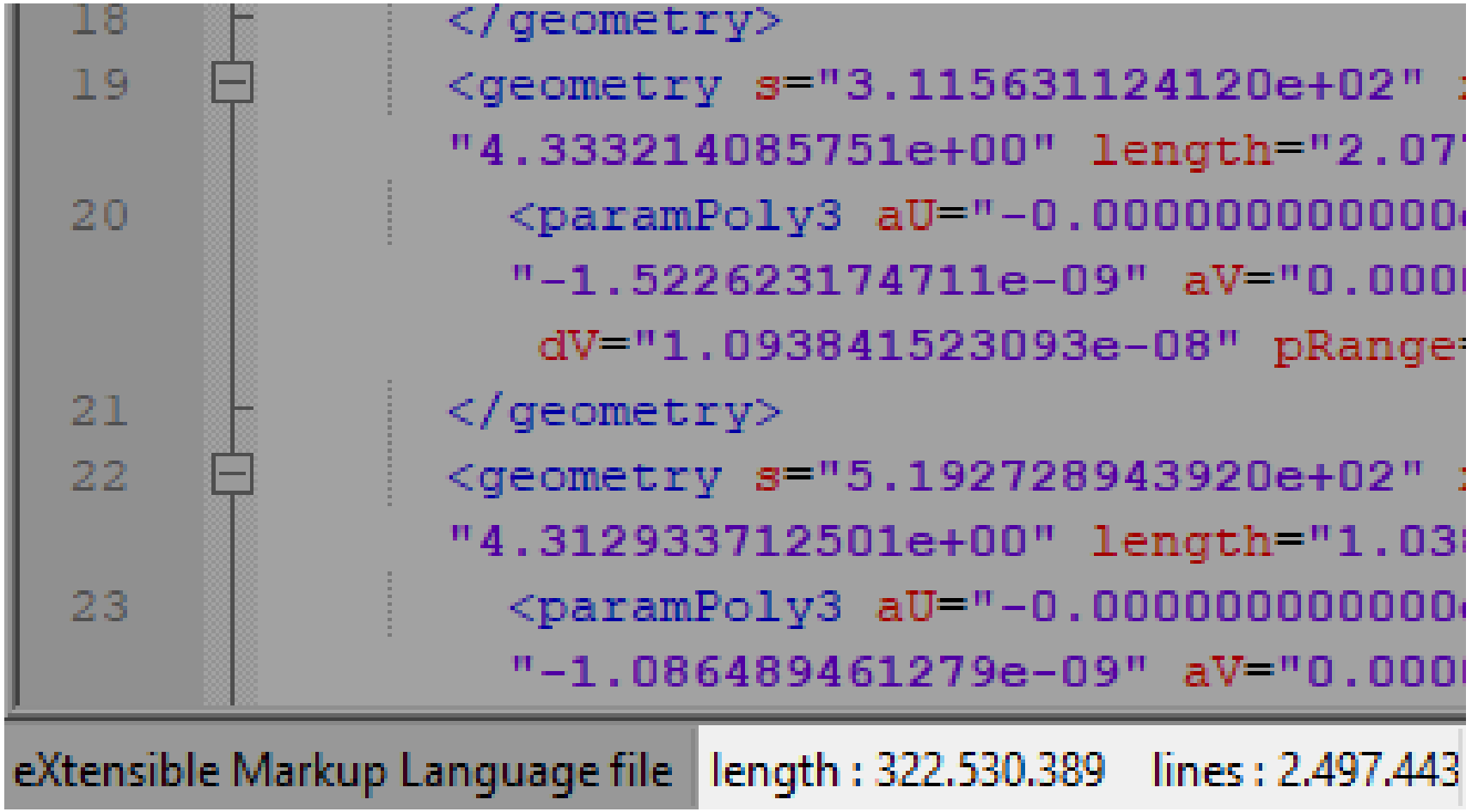
Current and future trends

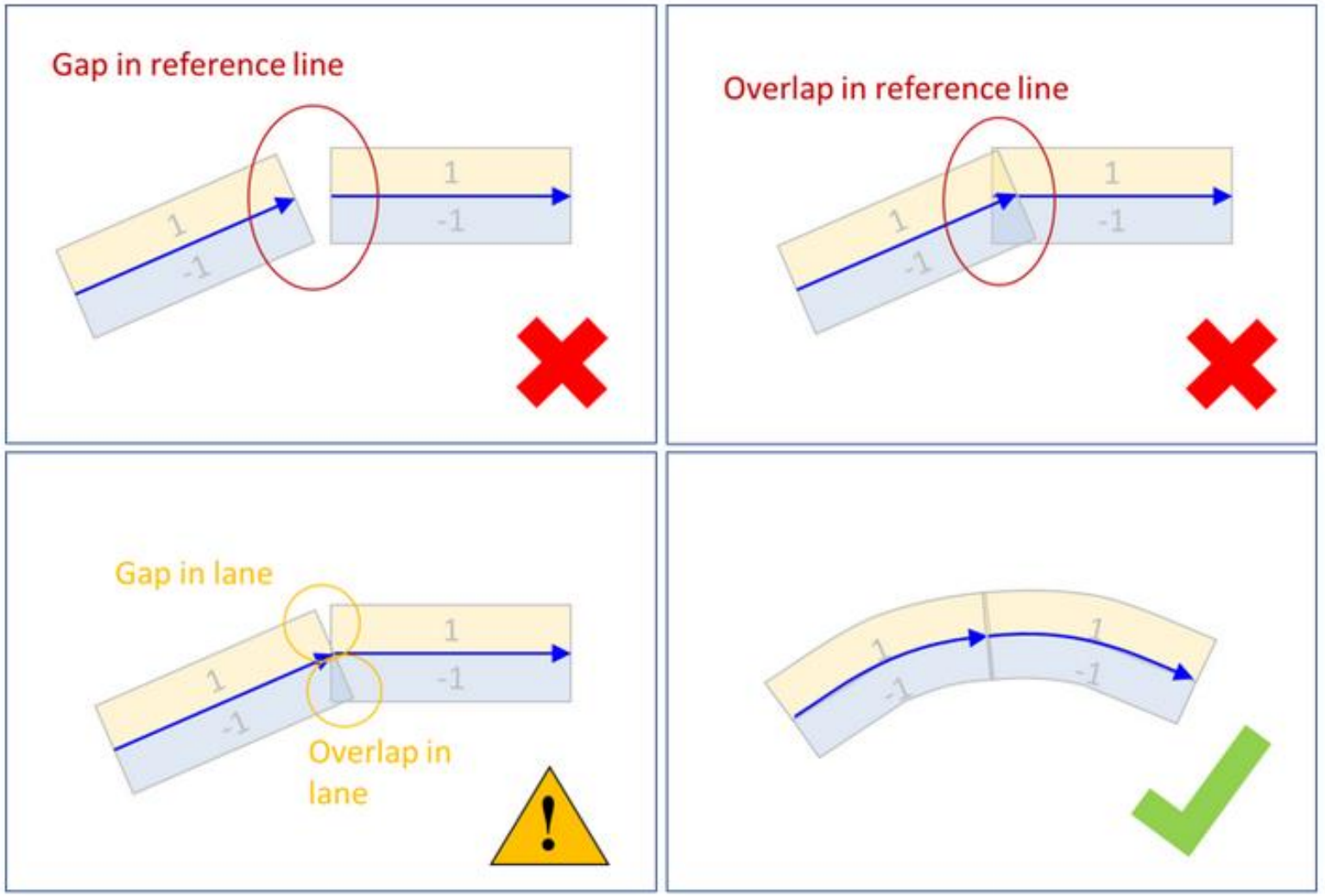
- Real-world data
  - From motorways over
  - inner cities to
  - multi-level parking decks
- Data updates and network merging
- Increasing spatial extents
- “From simulation into the car”
  → Electronic horizon, rejection of many elements
- Linkage to supplementary environmental data

OpenDRIVE challenges

Scalability

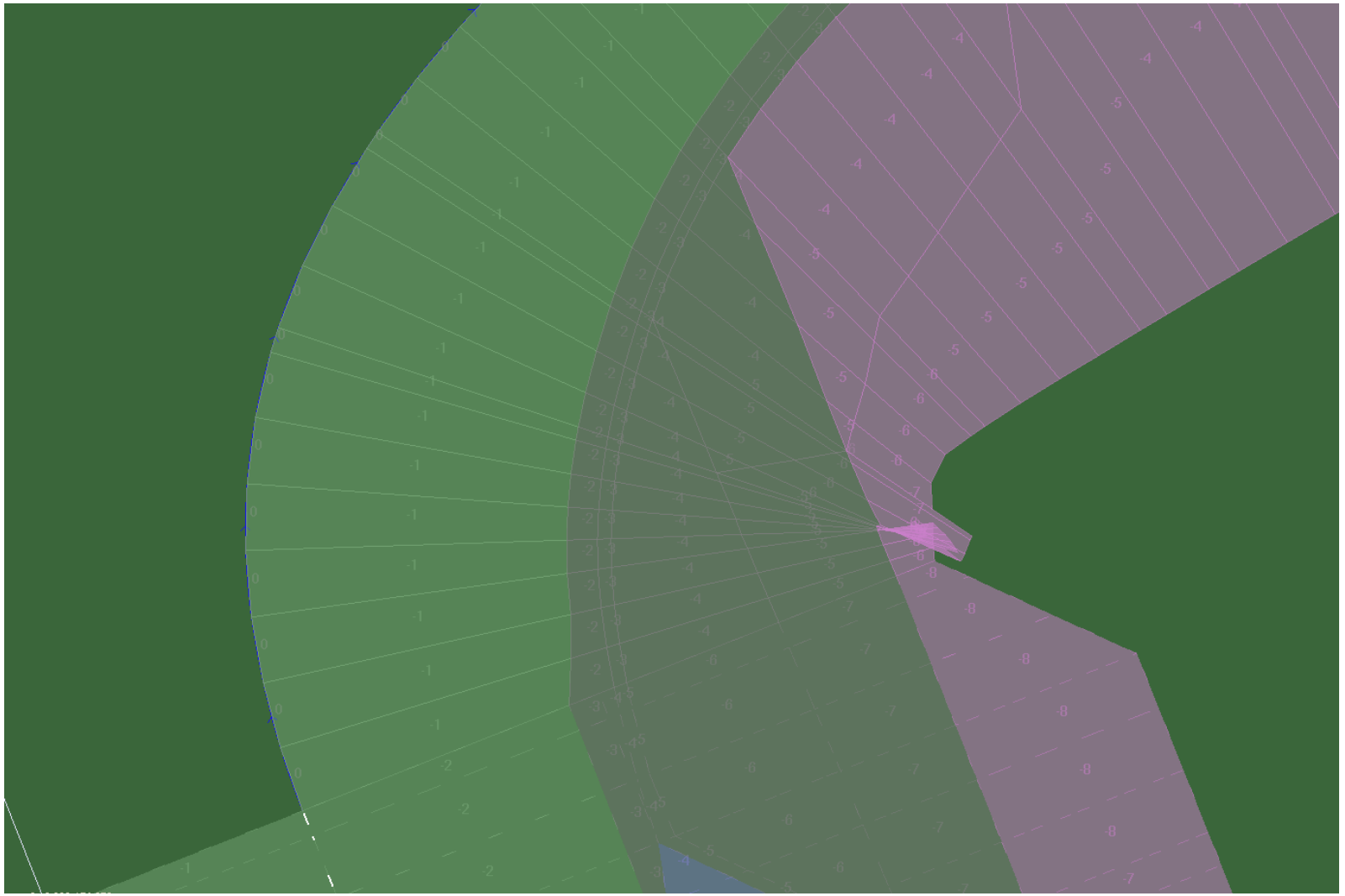


Modelling habits



see ASAM OpenDRIVE Format Specification, v. 1.6.0

Modelling habits (numerical restrictions)



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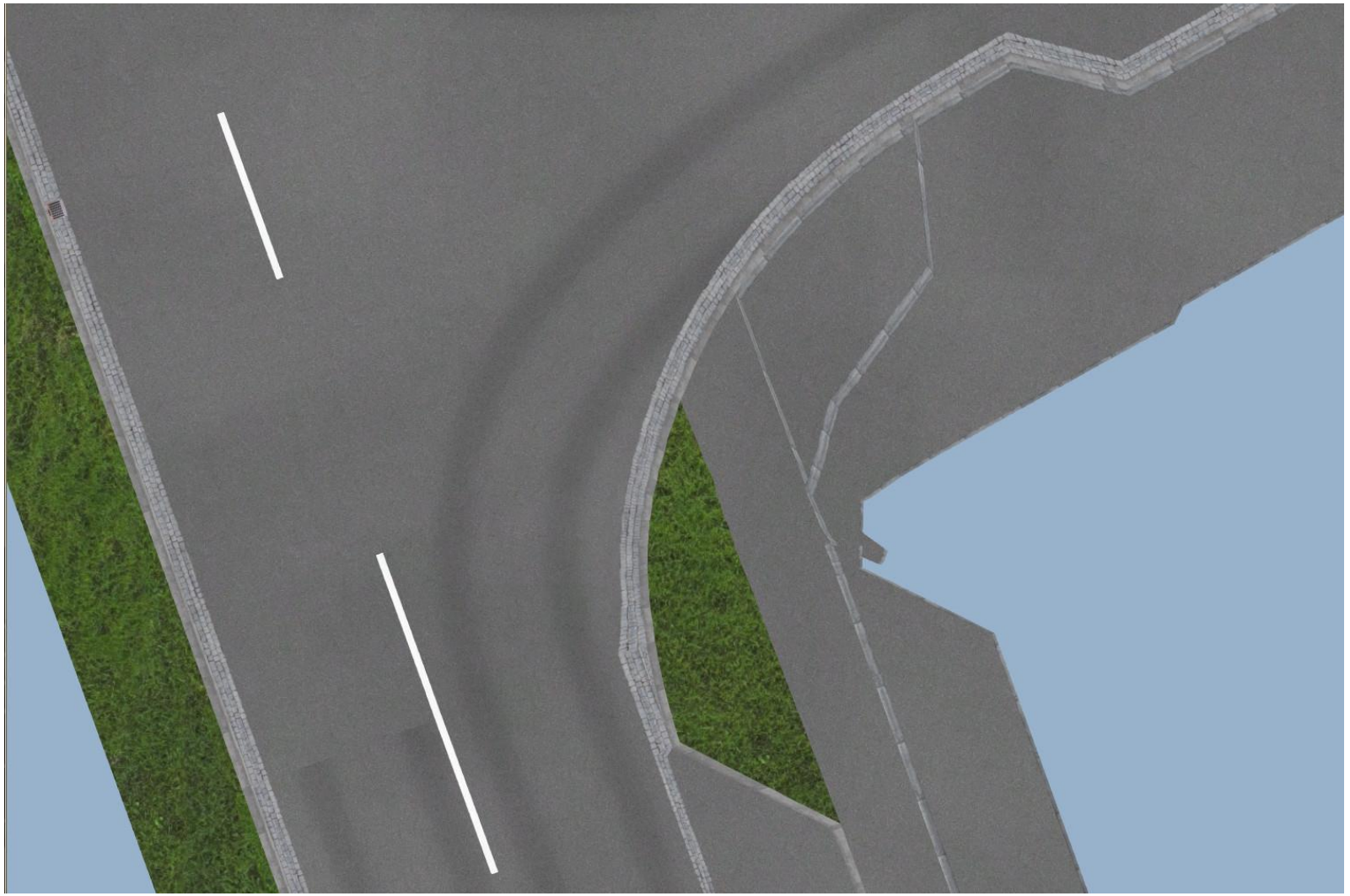
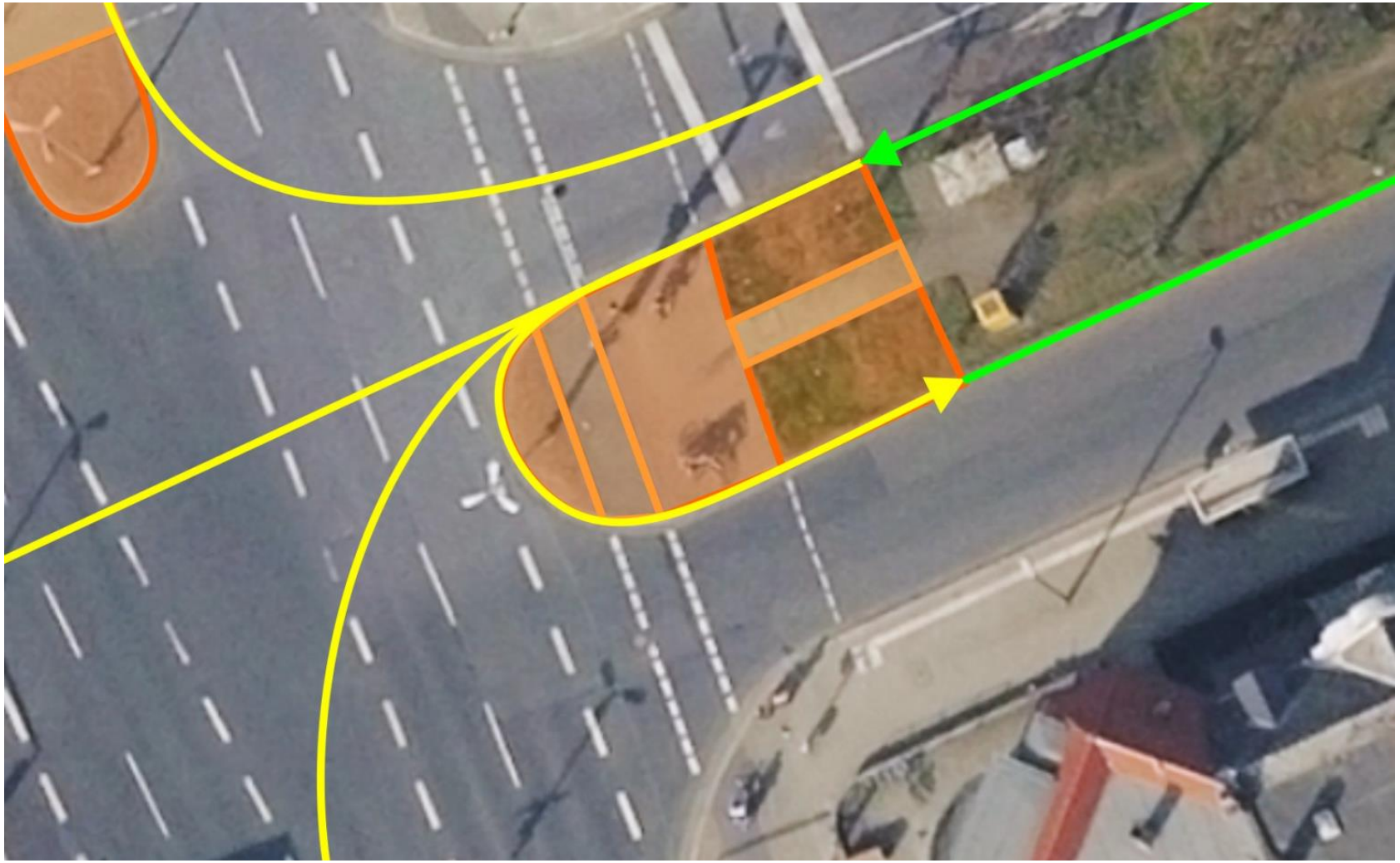


Structural separations, traffic islands



see Road2Simulation Guidelines Rev. 1.2.1

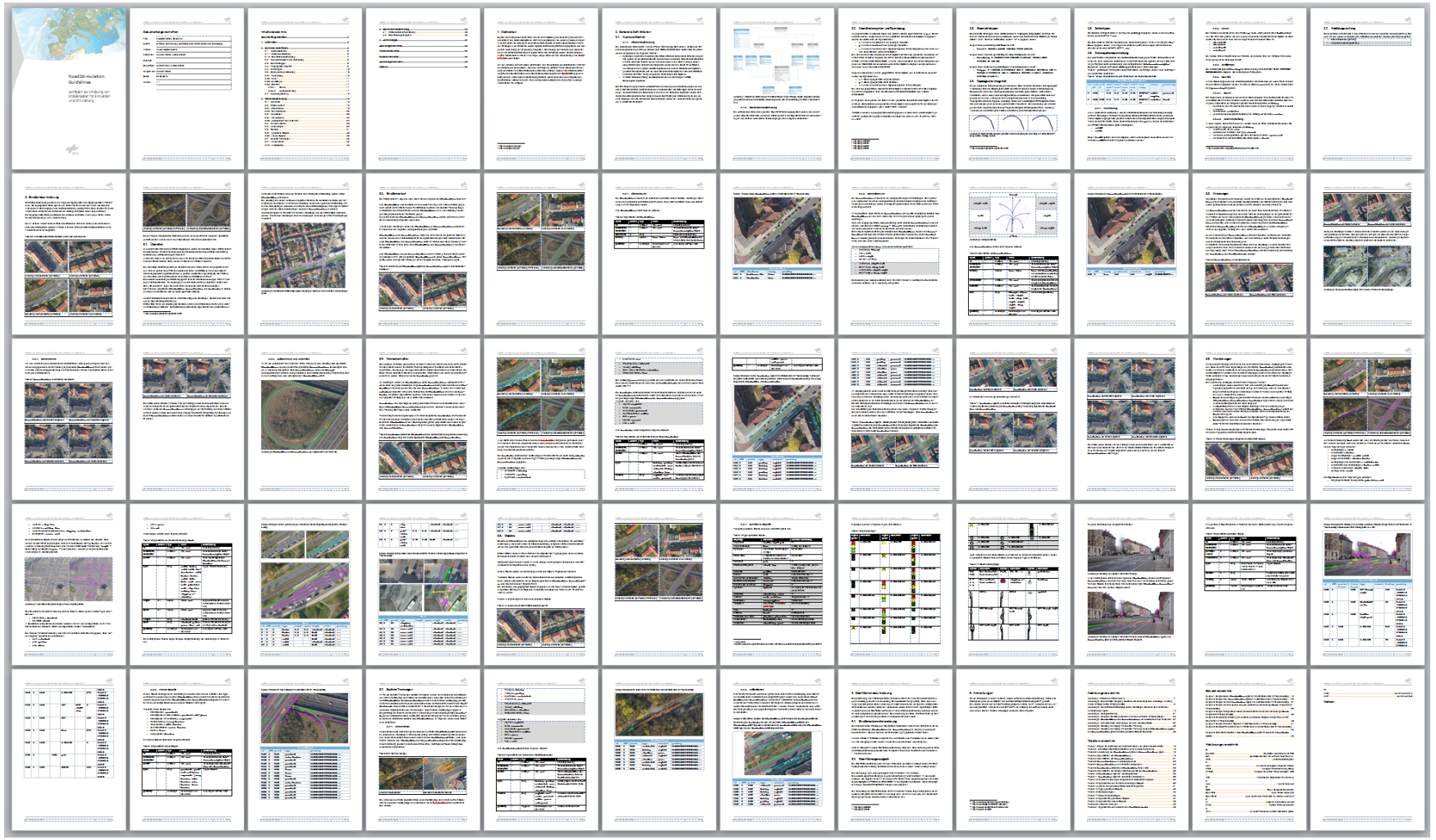
Data consistency

- Different mobile mapping providers
  → Heterogeneous modelling/post-processing
  → Incompatible datasets

- Difficult network merging and updates

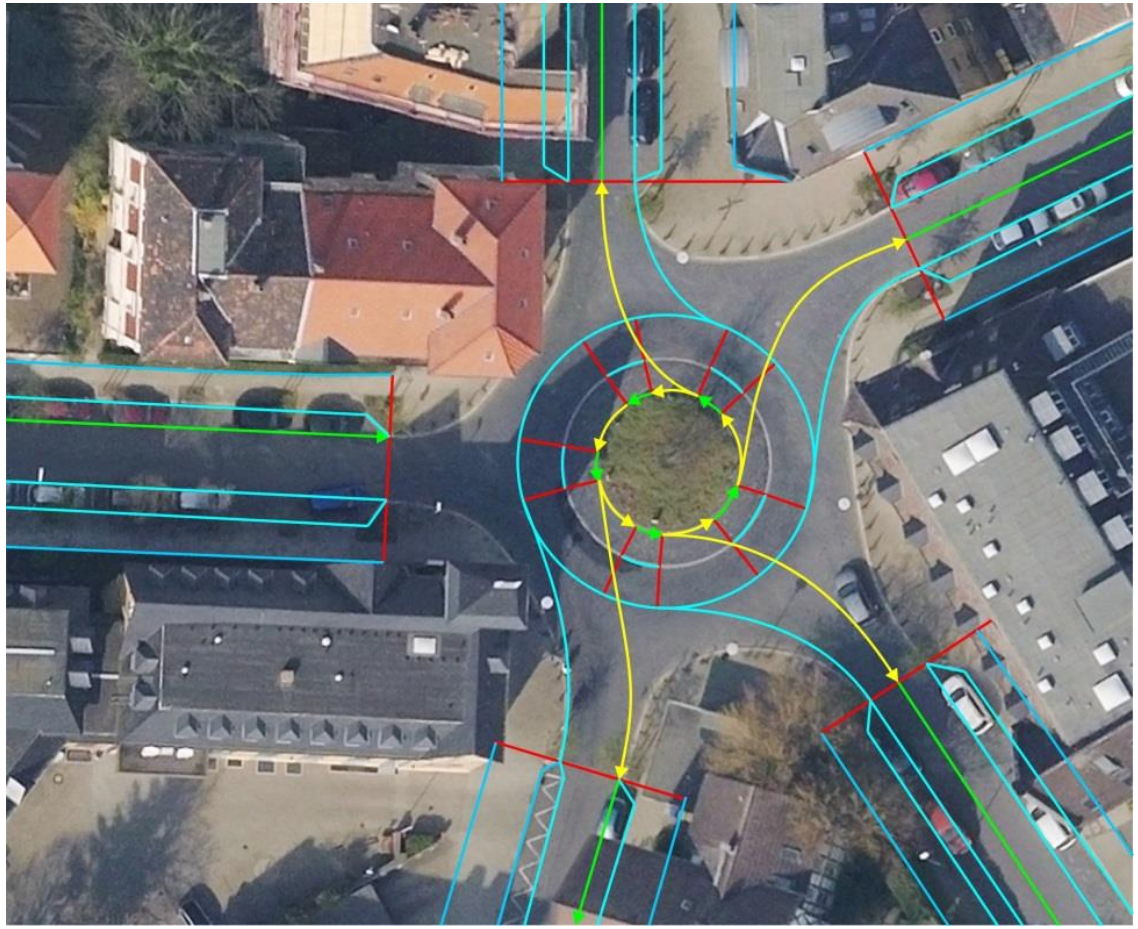
- Commercial tools overuse <UserData>
  → Cumbersome exchangeability

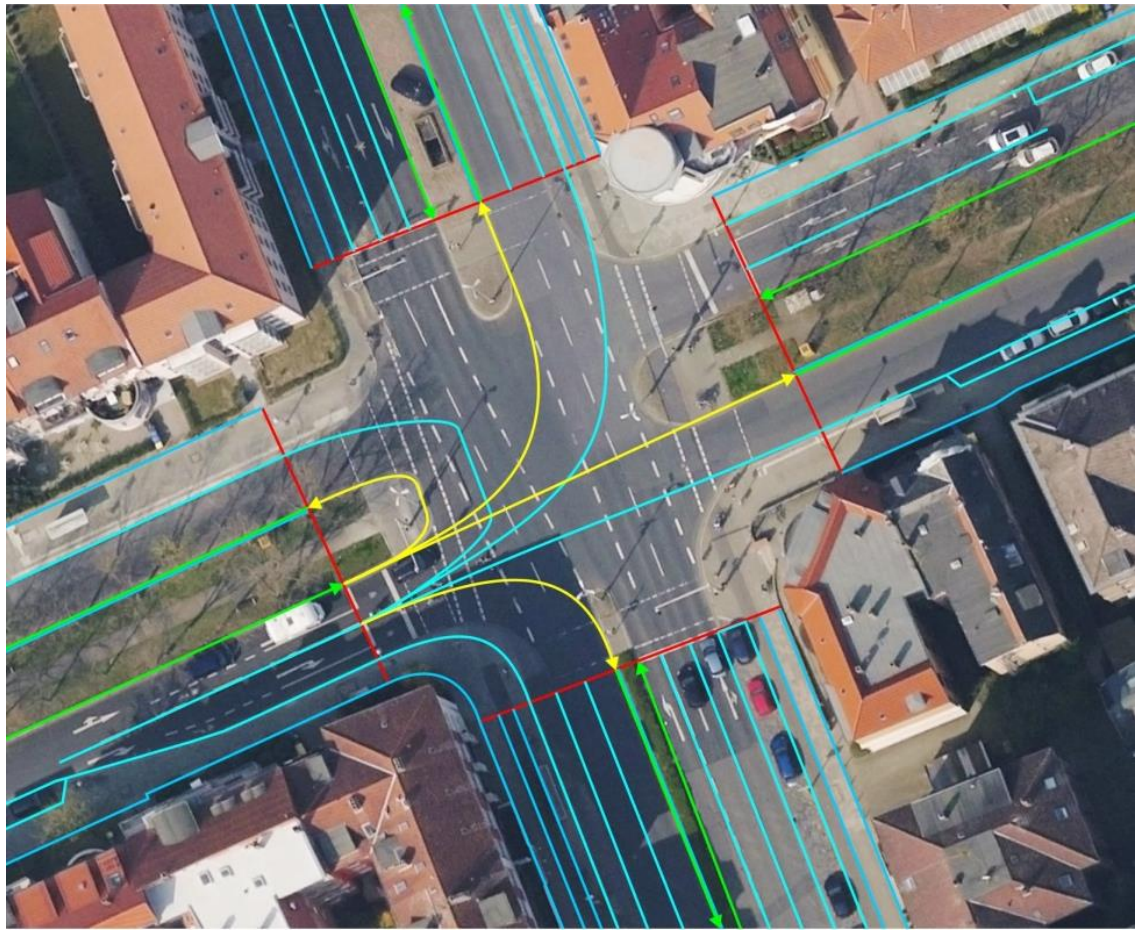
Road2Simulation Guidelines



see Road2Simulation Guidelines Rev. 1.2.1

Road2Simulation Guidelines: GIS-backed modelling





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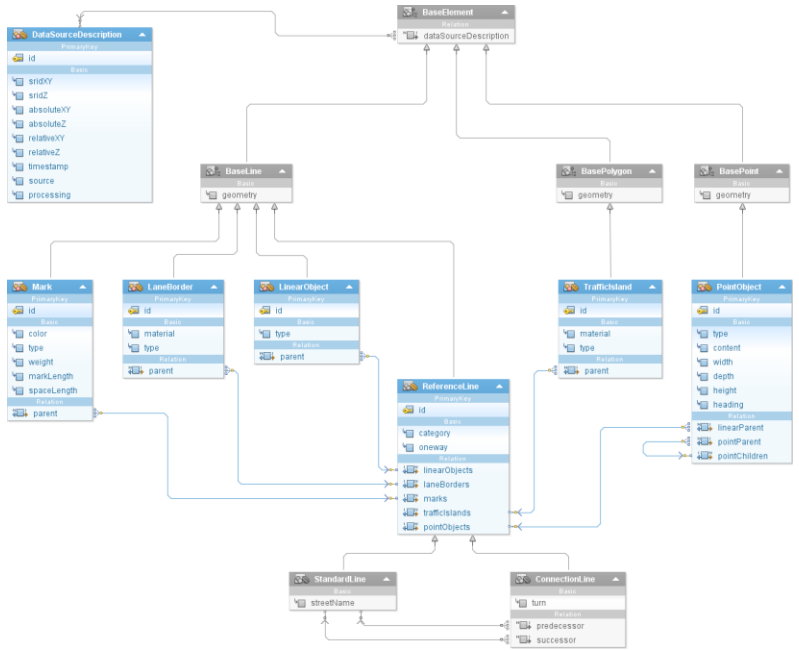
Road2Simulation Guidelines: tackling geometry representation

Intermediate geodata model



based on OGC
Simple Features

GIS processing

OpenDRIVE standardization

Standardization activities

2005 - 2019

- Open community-driven de facto standard
- Initiated by Vires GmbH and Daimler AG, maintained by Vires
- Resources: www.opendrive.org
- *OpenDRIVE versions <= 1.5*
  - *Latest release February 2019*

Standardization activities

2005 - 2019

- Open community-driven de facto standard
- Initiated by Vires GmbH and Daimler AG, maintained by Vires
- Resources: www.opendrive.org
- *OpenDRIVE versions <= 1.5*
  - *Latest release February 2019*
- Maintaining downwards compatibility (not always)
- Version 1.3 → 1.4
  - Adds new geometry type: paramPoly3
  - Extends lane boundary modelling
  - Extends lateral profile modelling
  - Introduces *PROJ.4 geo-reference*
  - Introduces parking spaces
  - Introduces railroad models for tramways
  - Introduces logic junction groups
- Version 1.4 → 1.5
  - Extends road mark modelling
  - Extends road object and signal modelling
  - Introduces *data quality information*

Standardization activities

2020 onwards

- Open automotive industry standard
- Association for Standardization of Automation and Measuring Systems (ASAM e. V.)
- Resources: https://www.asam.net/standards/detail/opendrive/
- *OpenDRIVE versions >= 1.6.0*
  - *First release March 2020*

Standardization activities

- Transfer to ASAM corporate layout
  → “Refurbishes and professionalizes 1.5”

2020 onwards

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  - *First release March 2020*

Standardization activities

- Transfer to ASAM corporate layout
  → “Refurbishes and professionalizes 1.5”

- Version 1.5 → 1.6.0
  - Optionalizes backwards-incompatible elements
  - Reworks basic specification text
  - Adds UML diagrams
  - Adds examples
  - Adds sample files

2020 onwards

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  - *First release March 2020*

ASAM OpenDRIVE Concept Project

- April 2019 – August 2020
- WP01: Improve the junction model
- WP02: Rework environmental representation
- WP03: Improve/extend geometry modelling
- WP04: International traffic sign model
- WP05: Area Concept

WP05: layered Area Concept (*fuelled by Road2Simulation*)

infrastructure layer	traffic signs, signals, etc.
road mark layer	markings and restrictions
trajectory layer (optional)	supporting centerlines
traffic island layer	developed traffic areas
lane layer (optional)	containing links
traffic area layer	for each transport mode/type
ground layer	TIN or CRG or height map

Standardization activities summarized

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https://youtu.be/diEnIUT6HmA

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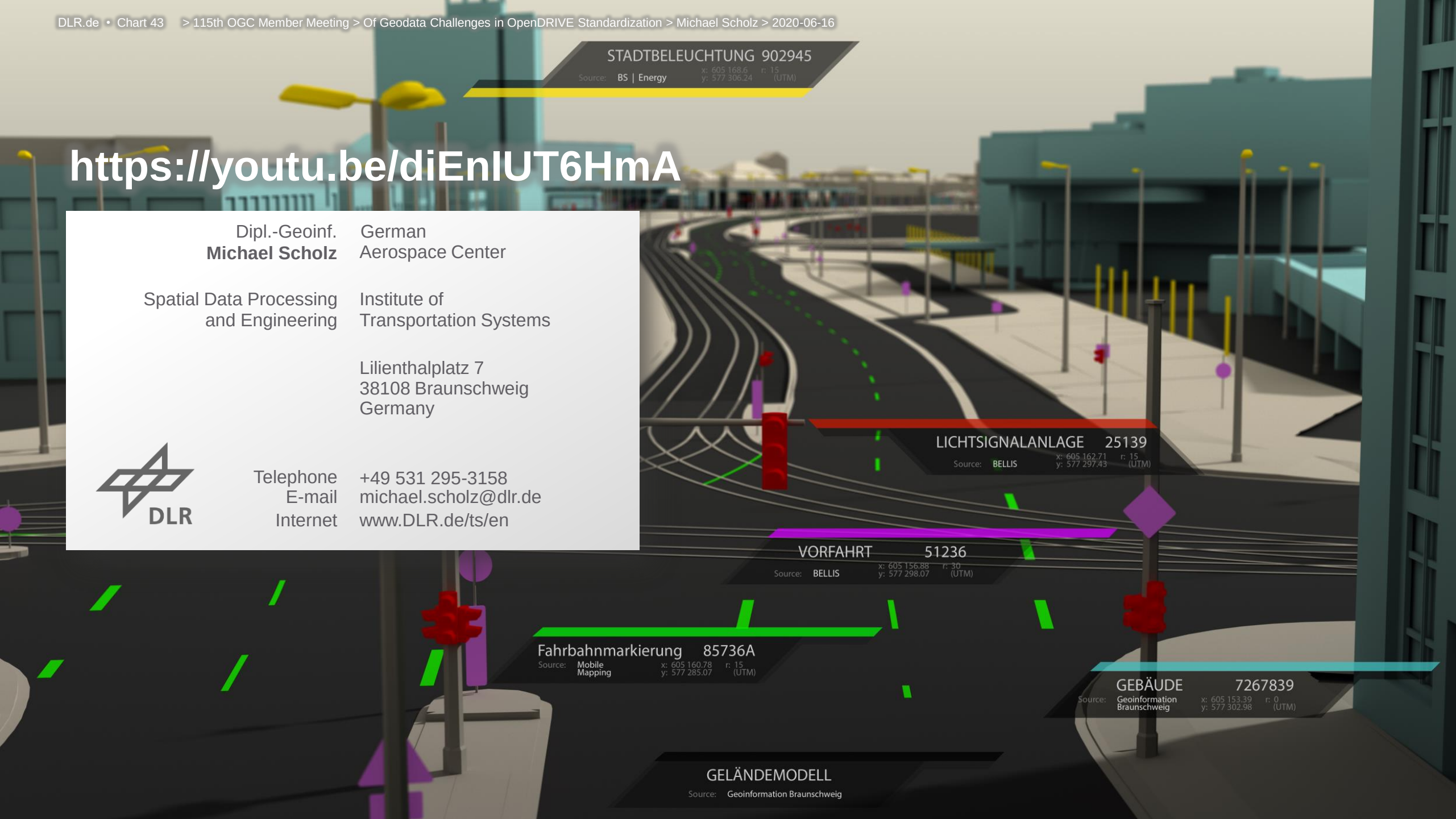
Internet www.DLR.de/ts/en



Additional resources

- Vires OpenDRIVE (version < 1.6.0): www.opendrive.org
- ASAM OpenDRIVE (version >= 1.6.0): https://www.asam.net/standards/detail/opendrive/
- Road2Simulation Guidelines: https://doi.org/10.5281/zenodo.3375525
- Unofficial GDAL OpenDRIVE extension: https://github.com/DLR-TS/gdal